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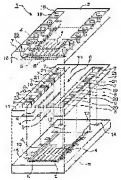
(54) ELECTROSTATIC CAPACITY DETECTION TYPE SENSOR, GYROSCOPE, AND INPUT DEVICE



(57)Abstract:

PROBLEM TO BE SOLVED: To provide an electrostatic capacity detection type sensor capable of suppressing the electric noise occurring around electrodes and improving detection sensitivity through the improvement of the S-N ratio.

SOLUTION: This gyroscope 1 is provided with a tuning fork 6 having three legs 9, driving electrodes 4 and detecting electrodes 5 provided on both glass substrates 2, 3, driving feedthroughs 7 feeding drive signals to the driving electrodes 4, and detecting feedthroughs 8 extracting detection signals from the detecting electrodes 5. Detection-drive shield sections 19, detection-detection shield sections 20, and drive-drive shield sections 21 electrostatically shielding between the feedthroughs are provided respectively between the adjacent feedthroughs arranged as the driving feedthroughs 7 and the detecting feedthroughs 8.

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* NOTICES *

CLAIMS

[Claim(s)]

[Claim 1] The structure, at least one electrode for a drive which drives this structure, and at least one track section for a drive which supplies a driving signal to this electrode for a drive, At least one electrode for detection which detects the variation rate of said structure driven with said electrode for a drive based on change of electrostatic capacity, It has at least one track section for detection which transmits the detecting signal from this electrode for detection. Between said electrode for a drive, and said electrode for detection, or between said track section for a drive, and said track section for detection The electrostatic-capacity detection mold sensor characterized by preparing the covered member which covers between inter-electrode [these] or the track section electrostatic.

[Claim 2] The electrode for a drive which counters with an oscillating piece and said oscillating piece, is prepared, and drives said oscillating piece, The electrode for detection which detects the variation rate of the direction which counters with the track section for a drive which supplies a driving signal, and said oscillating piece, is established in this electrode for a drive, and intersects perpendicularly with the driving direction of said oscillating piece, It has the track section for detection which transmits the detecting signal from this electrode for detection. Between said electrode for a drive, and said electrode for detection, or between said track section for a drive, and said track section for detection The gyroscope characterized by preparing the 1st covered member which covers

between inter-electrode [these] or the track section electrostatic.
[Claim 3] The gyroscope according to claim 2 characterized by forming both said oscillating piece, said track section for a drive, said track section for detection, and said 1st covered member on the same flat surface.
[Claim 4] The gyroscope according to claim 2 or 3 characterized by both said oscillating piece, said track section for a drive, said track section for detection, and said 1st covered member consisting of the same conductive ingredient.
[Claim 5] The gyroscope according to claim 2 characterized by having been prepared on the base material with which said electrode for a drive and said electrode for detection countered with said oscillating piece, and have been arranged, and preparing said 1st covered member between said electrode for a drive on this base material, and said electrode for detection, or between said track section for a drive, and said track section for detection.
[Claim 6] The electrode for a drive which counters with an oscillating piece and said oscillating piece, is prepared, and drives said oscillating piece, The electrode for detection which detects the variation rate of the direction which counters with the track section for a drive which supplies a driving signal, and said oscillating piece, is established in this electrode for a drive, and intersects perpendicularly with the driving direction of said oscillating piece, Have the track section for detection which transmits the detecting signal from this electrode for detection, and it consists of two or more electrodes with which either [at least] said electrode for a drive or said electrode for detection was separated mutually. The gyroscope characterized by preparing the 2nd covered member which covers between inter-electrode [these] or the track section electrostatic between the track sections connected to inter-electrode [which the electrode of these plurality adjoins], or a this adjoining electrode, respectively.
[Claim 7] The gyroscope according to claim 6 characterized by forming both said oscillating piece, the track section connected to said two or more electrodes, respectively, and said 2nd covered member on the same flat surface.
[Claim 8] The gyroscope according to claim 6 or 7 characterized by both said

oscillating piece, the track section connected to said two or more electrodes, respectively, and said 2nd covered member consisting of the same conductive ingredient.

[Claim 9] The gyroscope according to claim 6 characterized by having been prepared on the base material with which said electrode for a drive and said electrode for detection countered with said oscillating piece, and have been arranged, and preparing said 2nd covered member between the track sections connected to inter-electrode [which said two or more electrodes on said base material adjoin], or a this adjoining electrode, respectively.

[Claim 10] The gyroscope according to claim 4 or 8 characterized by said conductive ingredient being silicon.

[Claim 11] The input unit characterized by using the gyroscope of a publication for claim 2 thru/or any 1 term of 10.

[Translation done.]

* NOTICES *

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1.This document has been translated by computer. So the translation may not reflect the original precisely.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] Especially this invention relates to the configuration of the

circumference of the external ejection electrode in an electrostatic-capacity detection mold sensor about an electrostatic-capacity detection mold sensor, a gyroscope, and an input unit.

[0002]

[Description of the Prior Art] It has the structures, such as a cantilever and diaphram, and the sensor which detects the desired amounts of dynamics, such as acceleration and a pressure, is known from the former. By this kind of sensor, the method which detects the deformation of the cantilever produced when external force works, or diaphram as variation of electrostatic capacity is adopted from the former. As an example of this kind of sensor, the example of an electrostatic-capacity type acceleration sensor is shown in drawing 10 .

[0003] The sensor shown in drawing 10 consists of a silicon substrate 101 and two glass substrates 102,103 which pinch this. The elastic section 104 (cantilever), the weight 105, the electric conduction column 106, etc. are formed of the silicon substrate 101, and the weight 105 is supported possible [displacement] in response to the inertial force by acceleration at the tip of the elastic section 104. Moreover, the weight 105 and the electrode 107,108 which counters through a minute gap are formed on each glass substrate 102,103, respectively, and change of the electrostatic capacity between the weight 105-electrodes 107,108 at the time of a weight 105 displacing is taken out as a detecting signal. Although both the glass substrates 102,103 and a silicon substrate 101 are joined by the airtight condition by anode plate junction, since it is necessary to take an electric flow with the weight 105 inside a sensor, and an electrode 107,108, a hole 109 is formed in the top glass substrate 102, and the conductive layer 110,111 which consists of aluminum for connecting with an external circuit is formed in the front face of each hole 109. A conductive layer 110 is electrically connected with a weight 105 through the impurity layer 112, and the conductive layer 111 is electrically connected with the electric conduction column 106 through the impurity layer 113. Furthermore, the electric conduction column 106 is electrically connected with the electrode 107,108.

[0004] This kind of sensor is realized as a micro sensor which used the micro-machining technique. In that case, a silicon substrate is used for the structures, such as a cantilever and diaphram, and a glass substrate is used for the base material which pinches this in many cases. A silicon substrate is an ingredient in which micro processing is possible using a semi-conductor manufacturing technology, and it is because a glass substrate is a joinable ingredient using an anode plate conjugation method as easily as a silicon substrate. Moreover, it is also constituting the package of a sensor by closing both sides of a silicon substrate with a glass substrate. In order to take a flow with the structure and the electrode which consist of silicon enclosed in the package as mentioned above when this configuration is adopted, the takeoff connection of the conductor formed in the hole opened in the glass substrate, the electric conduction column formed by the silicon substrate, and the electrical signal called the so-called feed through etc. is needed.

[0005]

[Problem(s) to be Solved by the Invention] However, when taking out an electrical signal outside as a detecting signal, electrical noise occurred in the above-mentioned conventional electrostatic-capacity detection mold sensor, and there was a problem that a S/N ratio deteriorated and detection sensitivity fell in it.

[0006] In the case of the sensor of the type for which a cantilever and diaphram are made to exercise beforehand (vibration), this poses a remarkable problem especially, before external force works. Because, in addition to the electrode for detection, this kind of sensor has the electrode for a drive for driving a cantilever and diaphram. However, in the case of the micro sensor, the electrode for detection and the electrode for a drive are approached and formed into a minute dimension in many cases, and the electrode for detection and the electrode for a drive are in the condition that capacity coupling was carried out. Therefore, when a driving signal is supplied to the electrode for a drive, it is because an unnecessary electrical potential difference is guided to the electrode for detection in response to the effect of the signal and electrical noise occurs. furthermore,

like the above-mentioned example, in taking out a detecting signal by feed through, electrical noise occurs also in the form of the parasitic capacitance between the object for a drive, and the feed through for each detection.

[0007] Thus, the gyroscope using the tuning fork which consists of ingredients, such as silicon which has conductivity, as an example of the sensor which combined the electrode for a drive and the electrode for detection is known. This gyroscope vibrates the foot of a tuning fork to an one direction (drive), and when the angular velocity which makes the longitudinal direction of a foot a medial axis during vibration is inputted, it detects vibration of a direction perpendicular to said oscillating direction produced by Coriolis force. Since the magnitude of vibration produced by Coriolis force is equivalent to the magnitude of angular velocity, it can use this gyroscope as an angular-velocity sensor, for example, can apply it to the coordinate input unit of a personal computer etc.

[0008] In this gyroscope, although various devices for the improvement in detection sensitivity have been made, much more improvement in detection sensitivity is desired. In order to realize further improvement in detection sensitivity, the problem of the above-mentioned electrical noise cannot be bypassed in a gyroscope. Moreover, considering the present condition that detailed-ization of various sensors is progressing increasingly, it is considered that it becomes impossible to disregard not only the above-mentioned inter-electrode one for electrode-detection for a drive but generating of the electrical noise by capacity coupling the inter-electrode one for an electrode-drive for a drive, or inter-electrode [for / for detection / electrode-detection] depending on the drive of a sensor, or the method of detection.

[0009] This invention is made in order to solve the above-mentioned technical problem, it controls the electrical noise generated in the circumference of the electrode in a sensor as much as possible, and aims at offer of the electrostatic-capacity detection mold sensor which can aim at improvement in detection sensitivity by improvement in a S/N ratio, a gyroscope, and the input unit using this gyroscope.

[0010]

[Means for Solving the Problem] In order to attain the above-mentioned purpose, the electrostatic-capacity detection mold sensor of this invention The structure, at least one electrode for a drive which drives this structure, and at least one track section for a drive which supplies a driving signal to this electrode for a drive, At least one electrode for detection which detects the variation rate of said structure driven with said electrode for a drive based on change of electrostatic capacity, It has at least one track section for detection which transmits the detecting signal from this electrode for detection. Between said electrode for a drive, and said electrode for detection, or between said track section for a drive, and said track section for detection It is characterized by preparing the covered member which covers between inter-electrode [these] or the track section electrostatic.

[0011] The electrode for a drive which the gyroscope of this invention counters with an oscillating piece and said oscillating piece, is formed, and drives said oscillating piece, The electrode for detection which detects the variation rate of the direction which counters with the track section for a drive which supplies a driving signal, and said oscillating piece, is established in this electrode for a drive, and intersects perpendicularly with the driving direction of said oscillating piece, It has the track section for detection which transmits the detecting signal from this electrode for detection, and is characterized by preparing the 1st covered member which covers between inter-electrode [these] or the track section electrostatic between said electrode for a drive, and said electrode for detection, or between said track section for a drive, and said track section for detection.

[0012] In this invention, it connects with electrodes, such as an electrode for a drive, and an electrode for detection, electrically, and the "track section" at the time of calling it "the track section for a drive" and "the track section for detection" shows the whole part used as the transmission line which exchanges a signal among these electrodes. Therefore, "the feed through formed with silicon" stated by the term of a Prior art is contained in the "track section" of this invention.

[0013] Here, the gyroscope which has feed through is mentioned as an example, and an operation and effectiveness of this invention are explained. Drawing 6 (a) is the mimetic diagram showing the configuration of the conventional gyroscope. The electrode 61 for a drive and the electrode 62 for detection are arranged through the oscillating piece 60 (equivalent to the foot of a tuning fork), and the minute gap, and the feed through 63 for a drive for supplying a driving signal to the electrode 61 for a drive and the feed through 64 for detection for taking out a detecting signal from the electrode 62 for detection are connected to each electrodes 61 and 62, respectively. Capacity coupling of the feed through 63 for a drive and the feed through 64 for detection is carried out, and they set the capacity value to C1. Moreover, also between the oscillating piece 60 and the electrode 62 for detection, capacity is formed and the capacity value is set to C2.

[0014] When Vdrive=Vd is impressed to the feed through 63 for a drive as driver voltage (Vdrive) in this gyroscope, originally the detection electrical potential difference (Vdetect) from the feed through 64 for detection in the condition that the oscillating piece 60 is not displacing is Vdetect= {C1/(C1+C2)} and Vd, in spite of being Vdetect=0. -- (1)

The becoming electrical potential difference will be guided and it will become a noise at the time of this detecting a detecting signal.

[0015] Then, what is necessary is just to insert a covered member between the feed through for a drive, and the feed through for detection, in order to control generating of this noise. Drawing 6 (b) is the mimetic diagram showing the configuration of the gyroscope of this invention. In this configuration, the covered member 65 is formed between the feed through 63 for a drive, and the feed through 64 for detection, and the feed through 63 for a drive and the feed through 64 for detection will be in the condition of having been isolated electrically, by having grounded the covered member 65. Consequently, even if it impresses Vdrive=Vd to the feed through 63 for a drive, in the feed-through 64 side for detection, Vdetect=0 is realized and generating of a noise can be controlled.

[0016] Thus, in the electrostatic-capacity detection mold sensor of this invention,

since generating of the electrical noise by electrostatic induction is prevented by having prepared the covered member which covers between inter-electrode [these] or the track section electrostatic between the electrode for a drive, and the electrode for detection, or between the track section for a drive, and the track section for detection, when a S/N ratio improves, improvement in detection sensitivity can be aimed at. Since generating of electrical noise is prevented by similarly having prepared the 1st covered member which covers between inter-electrode [these] or the track section electrostatic between the electrode for a drive, and the electrode for detection, or between the track section for a drive, and the track section for detection in the gyroscope of this invention, when a S/N ratio improves, improvement in the detection sensitivity of angular velocity can be aimed at.

[0017] As [both] a concrete configuration of the gyroscope of this invention, an oscillating piece, the track section for a drive, the track section for detection, and the 1st covered member can be formed on the same flat surface. Moreover, all these members can be formed with the same conductive ingredient. An oscillating piece, the track section for a drive, the track section for detection, and the 1st covered member can be made from one semi-conductor substrate by being more specifically made from that to which micro processing gave conductivity to semi-conductor substrates, such as easy silicon, using the semi-conductor manufacturing technology, and processing this with photolithography and an etching technique. The configuration of this invention can be realized without complicating especially a manufacture process, if it considers as this configuration.

[0018] Or when it prepares on the base material which countered with the oscillating piece and has arranged the electrode for a drive, and the electrode for detection, you may make it prepare said 1st covered member between the electrode for a drive on a base material, and the electrode for detection, or between the track section for a drive, and the track section for detection. That is, although the example which forms the 1st covered member from the same silicon

as an oscillating piece was described in the top, when preparing the electrode for a drive, and the electrode for detection on the above-mentioned base material, the track section (wiring) connected to these electrodes at the electrode for a drive, the electrode for detection, and a list will specifically be formed on a base material using a metal thin film etc. In that case, if a metal thin film etc. is used also for the 1st covered member and this is prepared between the track section for a drive, and the track section for detection between the electrode for a drive on a base material, and the electrode for detection, between inter-electrode [these] or the track section can be covered too, and the same operation and effectiveness as the above can be acquired.

[0019] Moreover, the electrode for a drive which other gyroscopes of this invention counter with an oscillating piece and said oscillating piece, are formed, and drives said oscillating piece, The electrode for detection which detects the variation rate of the direction which counters with the track section for a drive which supplies a driving signal, and said oscillating piece, is established in this electrode for a drive, and intersects perpendicularly with the driving direction of said oscillating piece, Have the track section for detection which transmits the detecting signal from this electrode for detection, and it consists of two or more electrodes with which either [at least] said electrode for a drive or said electrode for detection was separated mutually. It is characterized by preparing the 2nd covered member which covers between inter-electrode [these] or the track section electrostatic between the track sections connected to inter-electrode [which the electrode of these plurality adjoins], or a this adjoining electrode, respectively.

[0020] As mentioned above, it is most effective to cover between the electrode for a drive and the electrodes for detection or between the track section for a drive and the track sections for detection about control of electrical noise. However, if during a drive-drive and during detection-detection are covered depending on the method of the configuration of a gyroscope, a drive, or detection, generating of a noise may be able to be controlled further. For

example, the electrode for detection does not consist of electrodes of one **, but it consists of two or more separated electrodes. And the electrode of these plurality is assigned by the electrode with which capacity change just becomes when an oscillating piece displaces to an one direction, and the electrode which becomes negative. If the electrode with which the above-mentioned capacity change just becomes, and the electrode which becomes negative adjoin in the case of the gyroscope of the type which performs differential detection by inter-electrode [these], changing the detection electrical potential difference of one electrode in response to the effect of the detection electrical potential difference of the electrode of another side etc. will be considered. In such a case, by preparing the 2nd covered member which covers between the adjoining inter-electrode one for detection, or the track section for detection electrostatic, the adjoining effect from an electrode or the track section can be lost, and improvement in detection precision can be aimed at.

[0021] Both an oscillating piece, the track section connected to two or more electrodes, respectively, and the 2nd covered member as well as the 1st covered member mentioned above can be formed on the same flat surface also about the 2nd covered member which covers during a drive-drive and during detection-detection. Moreover, these members can be formed with the same conductive ingredient. Also by this configuration, the same operation and effectiveness as the case of the 1st covered member mentioned above can be acquired.

[0022] Moreover, when it prepares on the base material which countered with the oscillating piece and has arranged the electrode for a drive, and the electrode for detection, said 2nd covered member may be prepared between the track sections connected to inter-electrode [which two or more electrodes on a base material adjoin], or an adjoining electrode, respectively. It is completely the same as that of the case of the 1st covered member also about this point.

[0023] The input device of this invention is characterized by using the gyroscope of above-mentioned this invention. According to this invention, the input unit excellent in responsibility is realizable by having used the gyroscope of high this

invention of detection sensitivity.

[0024]

[Embodiment of the Invention] The gestalt of operation of the 1st of this invention is explained with reference to drawing 1 thru/or drawing 4 below [the gestalt of the 1st operation]. the decomposition perspective view in which drawing 1 shows the whole gyroscope configuration of the gestalt of this operation, the perspective view showing the condition that drawing 2 combined each part material, the sectional view where drawing 3 meets the III-III line of drawing 2 , and the sectional view where drawing 4 meets the IV-IV line of drawing 2 -- it comes out. the sign 2 in drawing -- a top glass substrate (base material) and 3 -- a bottom glass substrate (base material) and 4 -- the electrode for a drive, and 5 -- the electrode for detection, and 6 -- a tuning fork and 7 -- the feed through for a drive (track section for a drive), and 8 -- the feed through for detection (track section for detection) -- it comes out. In addition, in order to make a drawing legible, the component is suitably omitted with the drawing.

[0025] The tuning fork 6 of the 3-piece mold with which the gyroscope 1 of the gestalt of this operation has the supporter 10 which connects these end face side with three feet 9 (oscillating piece) as shown in drawing 1 and drawing 2 is used. Moreover, the frame part 11 is formed so that the perimeter of a tuning fork 6 may be surrounded, and these tuning forks 6 and a frame part 11 are formed from the silicon substrate of one sheet which has about 200-micrometer conductivity in **** from the first. As shown in drawing 3 , while a frame part 11 is pinched and fixed between the top glass substrate 2 and the bottom glass substrate 3 The upper part of a tuning fork 6 and the field in which it is located caudad serve as the crevices 2a and 3a with a depth of about 10 micrometers among the insides of two glass substrates 2 and 3. By an about 10-micrometer gap being formed between each glass substrates 2 and 3 and a tuning fork 6, each foot 9 of a tuning fork 6 can be in the condition of having floated in the air, and can vibrate.

[0026] Both the glass substrates 2 and 3 and a frame part 11 are joined to glass

by anode plate junction of silicon. Therefore, a tuning fork 6 will be arranged in the space held by both the glass substrates 2 and 3 and the frame part 11 at the airtight condition. Furthermore, the duty of the package of this gyroscope 1 has also achieved both the glass substrates 2 and 3.

[0027] As shown in drawing 1 and drawing 2 , a total of every the six two-piece electrodes 4 for a drive is extended and prepared in the location which counters the end face side of the foot 9 in crevice 2a of top glass substrate 2 inferior surface of tongue at the longitudinal direction of a foot 9 at each foot 9. The electrode 4 for a drive Aluminum film or chromium film of about 300nm of thickness, Or the film which carried out the laminating of the platinum film of about 70nm of thickness on the titanium film of about 30nm of thickness (It is hereafter described as platinum / titanium film) etc. -- from -- it is formed and the wiring 12 for a drive for supplying a driving signal to the electrode 4 for a drive is formed in one with the same aluminum film of a layer or same chromium film as an electrode, or platinum / titanium film. Moreover, a total of every the six two-piece electrodes 5 for detection is extended and prepared in the location which counters the tip side of a foot 9 rather than the above-mentioned electrode 4 for a drive at the longitudinal direction of a foot 9 at each foot 9. This electrode 5 for detection is also formed with the same ingredient as the electrode 4 for a drive, and the wiring 13 for detection is formed succeeding each electrode 5 for detection, respectively. Furthermore, in the part located in the outside of crevice 2a of top glass substrate 2 inferior surface of tongue, the middle pad sections 14 and 15 which consist of the same metal thin film are formed at the tip of the wiring 12 for a drive, and the wiring 13 for detection.

[0028] Moreover, the configuration of the wiring 12 for a drive connected to the electrode 4 for a drive, the electrode 5 for detection, and these electrodes 4 and 5 and the wiring 13 for detection is completely the same at the top glass substrate 2 and the bottom glass substrate 3 which were explained in the top.

[0029] Although the tuning fork 6 and the frame part 11 are formed in one as shown in drawing 1 and drawing 2 , along with the longitudinal direction of a

tuning fork 6, a total of every six feed through 7 for a drive and feed through 8 for detection which become the method of both sides of a tuning fork 6 from the piece of silicon of the shape of an island isolated from the tuning fork 6 and the frame part 11 is prepared. [12] Three feed through to which three feed through located in the tip side of a foot 9 among the feed through of one trains [six] is located in the feed-through 8 for detection and end face side of a foot 9 supports the feed through 7 for a drive.

[0030] And when the gyroscope 1 in drawing 1 and drawing 2 is seen from a transverse plane, three feed through 8 for detection of a left column is assigned to the signal ejection of the electrode 5 for detection of three left-hand side, and supports each electrode 5 for detection which each feed through 8 for detection turned to a back side from a near side turns to a left end from a central site. On the other hand, although three feed through 7 for a drive of a left column is also assigned to the signal supply to the electrode 4 for a drive of three left-hand side, each feed through 7 for a drive turned to a back side from a near side supports the electrode 4 for a drive turned to a central site from a left end. Similarly, the feed through 8 for detection and the feed through 7 for a drive of a right column are assigned to the right-hand side electrode 5 for detection and the right-hand side electrode 4 for a drive, respectively. Although these feed through 7 and 8 is isolated from the tuning fork 6 or the frame part 11, it is formed from the same silicon substrate and has conductivity like the tuning fork 6 or the frame part 11.

[0031] The connection relation of both the glass substrates 2, the wiring 13 for detection on three, the wiring 12 for a drive, the feed through 8 for detection, and the feed through 7 for a drive is explained using drawing 4 . In addition, although a detection side is mentioned as an example and explained here, a driving side is also the completely same configuration. As shown in drawing 4 , the middle pad section 15 which leads to the wiring 13 for detection is formed in the top face of the bottom glass substrate 3, and the inferior surface of tongue of the top glass substrate 2, respectively, and the feed through 8 for detection is joined by the formation location of the middle pad section 15. And the electric conduction film

which the taper-like through hole 16 was formed in the location corresponding to the feed through 8 for detection of the top glass substrate 2, and was formed in accordance with the inside of a through hole 16 extends on the top face of the top glass substrate 2, and serves as the pad section 17 for external connection. This electric conduction film is film of two-layer structure with which chromium of about 50nm of thickness was turned for example, on the lower layer side, and it carried out the laminating of the gold of about 1000nm of thickness to the upper layer side. Therefore, when plane view of the gyroscope 1 is carried out, the two middle pad sections 15 and feed through 8 for detection which are prolonged from the electrode 5 for detection in the same location are connected electrically, and when the feed through 8 for detection and the pad section 17 for external connection contact in a through hole 16, it connects electrically. Moreover, the pad section 17 for external connection is connected with an external circuit (not shown) by means, such as wirebonding, and a detecting signal is taken out by the external circuit through the path of the electrode 5 for detection, the feed through 8 for detection, and the pad section 17 for external connection. In addition, the sign 18 in drawing 1 and drawing 2 is the pad section for external connection electrically connected with the electrode 4 for a drive.

[0032] Although opposite arrangement of a total of every the four two-piece electrodes 5 for detection is carried out with each glass substrates 2 and 3 to each foot 9 as shown in drawing 4 Opposite arrangement is not necessarily carried out so that the edges of the displacement detection direction (the direction of X in drawing) of each outer edge and foot 9 of two electrodes 5 for detection on one glass substrate may gather completely. The outer edge of each electrode 5 for detection and the edge of a foot 9 are arranged at the condition that only the distance more than the maximum amplitude of the displacement detection direction of a foot 9 shifted. Moreover, the width of face of each electrode 5 for detection is set as the dimension more than the maximum amplitude of a foot 9. According to this configuration, when a foot 9 displaces rightward [space] (the direction of an arrow head R), in order that an opposed

face product may increase, capacity change serves as forward, and in order that an opposed face product may decrease, by the electrode 5 side for detection overflowing into the left-hand side of a foot 9, capacity change serves as negative at the electrode 5 side for detection overflowing into the right-hand side of a foot 9. Therefore, such capacity variation can be detected separately and differential detection can be performed. In this case, since the initial capacity value in two capacity value is mutually equal, if difference is taken, a part for initial capacity value will be eliminated and only capacity variation will remain. Therefore, the noise component contained in initial capacity value can be canceled, and detection precision can be raised.

[0033] As shown in drawing 1 and drawing 2 , the adjoining feed through 7 and the wall located among eight are formed in the part by which the feed through 7 for a drive and the feed through 8 for detection were arranged, respectively. These walls are formed in a frame part 11 and one. Although five walls are prepared among six feed through in the train of one side, among five walls, the central wall has achieved the duty which covers between adjoining feed through 8 for detection and feed through 7 for a drive electrostatic, and constitutes the detection-drive electric shielding section 19 (1st covered member). The wall of two near sides has achieved the duty which covers between the adjoining feed through 8 for detection electrostatic, and constitutes the detection-detection electric shielding section 20 (2nd covered member). The back side, two walls have achieved the duty which covers between the adjoining feed through 7 for a drive electrostatic, and constitute the drive-drive electric shielding section 21 (2nd covered member).

[0034] Furthermore, although illustration is omitted since especially the function top of a gyroscope 1 is not required and it is required for convenience' sake on the manufacture mentioned later In fact The inferior-surface-of-tongue side of the electrode 5 for detection and the wiring 13 for detection, the electrode 4 for a drive, and top glass substrates 2 other than the formation field of the wiring 12 for a drive, And the same-electric-potential pattern which is from these electrodes

and the same aluminum film as wiring, the chromium film, or platinum / titanium film on the top-face side of the bottom glass substrate 3 is prepared.

[0035] In case the gyroscope 1 of the above-mentioned configuration is manufactured, a glass substrate is prepared first, fluoric acid etching of a glass substrate is performed using mask material, and Crevices 2a and 3a are formed in the field corresponding to the location of the tuning fork 6 on a glass substrate. Then, after forming a metal membrane to the field in which Crevices 2a and 3a were formed, the electrode 5 for detection, the wiring 13 for detection, the electrode 4 for a drive, the wiring 12 for a drive, and a same-electric-potential pattern are formed by carrying out patterning using photolithography and an etching technique. The bottom glass substrate 3 is completed according to the above process. About the top glass substrate 2, a through hole 16 is also formed further and the pad sections 17 and 18 for external connection are formed by membrane formation of a metal membrane, and patterning.

[0036] Next, a silicon substrate is prepared and the inferior surface of tongue and the bottom glass substrate 3 of a silicon substrate are joined using an anode plate conjugation method. Under the present circumstances, the part which serves as a frame part 11 among silicon substrates later is joined. Since there are only about 10 micrometers of no gaps with bottom glass substrate 3 front face, when a silicon substrate bends with the electrostatic attraction at the time of anode plate junction and the bottom glass substrate 3 is contacted, the part will also be joined and it becomes impossible to form the tuning fork which can vibrate in the part from which a silicon substrate serves as a tuning fork 6, although forward can be impressed to a silicon substrate, electronegative potential can be impressed to a glass substrate and glass can be easily joined to silicon in an anode plate conjugation method. Therefore, in order to prevent that the part which should be joined to the bottom glass substrate 3 and which does not come out will be joined and to make the part of the bottom glass substrate 3 into a silicon substrate and same electric potential, the same-electric-potential pattern is formed in bottom glass substrate 3 front face. This point is the same

also about the top glass substrate 2.

[0037] Next, the resist pattern which has the configuration of a part of leaving a tuning fork 6, a frame part 11, the feed through 8 for detection, the feed-through 7 grade for a drive, and silicon is formed in a silicon substrate surface, and etching which penetrates a silicon substrate using anisotropic etching, such as reactive ion etching, is performed. Thereby, a tuning fork 6, a frame part 11, the feed through 8 for detection, and the feed-through 7 grade for a drive are formed, and the part of a tuning fork 6 will be in the condition of having floated in the air in the upper part of the bottom glass substrate 3. Then, a resist pattern is exfoliated.

[0038] Next, the top face and the top glass substrate 2 of a silicon substrate which were joined to the bottom glass substrate 3 are joined using an anode plate conjugation method. Also in this case, a frame part 11 will be joined to the top glass substrate 2. The gyroscope 1 of the gestalt of this operation is completed according to the above process.

[0039] In case the gyroscope 1 of the gestalt of this operation is used, while grounding a frame part 11, the oscillator as a driving source is connected to external wiring connected to the pad section 18 for external connection by the side of the electrode 4 for a drive. Under the present circumstances, a frame part 11, a tuning fork 6, the detection-drive electric-shielding section 19, the detection-detection electric-shielding section 20, and the drive-drive electric-shielding section 21 will be in the condition that all were grounded, in a tuning fork 6, the detection-drive electric shielding section 19, the detection-detection electric-shielding section 20, and the drive-drive electric-shielding section 21, if it becomes with same electric potential and a frame part 11 is grounded, since it is one altogether. Moreover, while connecting the 1st capacitive detector between external wiring and the tuning forks 6 which were connected to the pad section 17 for external connection of the electrode 5 for detection protruded into the right-hand side of each foot 9 in drawing 4 , the 2nd capacitive detector is connected between external wiring and the tuning forks 6 which were connected to the pad section 17 for external connection of the electrode 5 for detection overflowing into

the left-hand side of each foot 9.

[0040] Then, if an oscillator is driven and a driving signal with a frequency of about several kHz is impressed between the electrodes 4 for a tuning fork 6-drive, each foot 9 of a tuning fork 6 will vibrate in the direction of a vertical. If the angular velocity which sets a revolving shaft as the longitudinal direction of a foot 9 is inputted in the condition, the horizontal vibration according to the magnitude of the inputted angular velocity will arise. Since it is in the condition that each foot 9 and the electrode 5 for detection of a tuning fork 6 countered, at this time and the opposed face product of each foot 9 and each electrode 5 for detection changes in connection with the horizontal vibration of a foot 9, capacity change arises. The magnitude of angular velocity is detectable by carrying out differential detection of the capacity variation at this time with the 1st capacitive detector and 2nd capacitive detector.

[0041] In the gyroscope 1 of the gestalt of this operation, since the electrical noise guided to the feed through 8 for detection by impression of a driving signal since between these feed through 7 and 8 is covered electrostatic by having formed the detection-drive electric shielding section 19 between the feed through 7 for a drive and the feed through 8 for detection is controlled, when a S/N ratio improves, improvement in the detection sensitivity of angular velocity can be aimed at.

[0042] Furthermore, in the case of the gyroscope 1 of the gestalt of this operation, differential detection is performed, and since a detecting signal which is different from the adjoining feed through 8 for detection is taken out, there is a possibility of changing a detecting signal in response to the effect of the signal of adjoining feed through. In that respect, by having formed the detection-detection electric shielding section 20 also in the adjoining feed through 8 for detection, the effect from the adjoining feed through 8 for detection is eliminated, and improvement in detection precision can be aimed at.

[0043] Moreover, the configuration of the gestalt of this operation can be realized using a general silicon processing technique, without complicating especially a

manufacture process, since a tuning fork 6, a frame part 11, the feed through 7 for a drive, the feed through 8 for detection, the detection-drive electric shielding section 19, the detection-detection electric shielding section 20, and the drive-drive electric shielding section 21 are altogether formed from the silicon substrate of one sheet.

[0044] Moreover, since the tuning fork 6 is pinched between two glass substrates 2 and 3, the part of a tuning fork 6 is protected by glass substrates 2 and 3, and it is easy to deal with the gyroscope 1 of the gestalt of this operation with them. Furthermore, since it is the structure where dust cannot go into the part of a tuning fork 6 easily, disturbance is controlled and sensor precision can be improved. Moreover, it is the structure where a vacuum lock can also be performed, according to this, improvement in Q value (performance index showing the magnitude of resonance) can be aimed at, and since the conversion efficiency from the electrical energy supplied to a device to vibrational energy improves, reduction of driver voltage can be aimed at.

[0045] The gestalt of operation of the 2nd of this invention is explained with reference to drawing 5 below [the gestalt of the 2nd operation]. Drawing 7 is the top view showing the whole gyroscope configuration of the gestalt of this operation. Although the basic configuration of the gyroscope of the gestalt of this operation is the same as that of the gestalt of the 1st operation, the point that the gyroscope of the gestalt of this operation differs from the gestalt of the 1st operation is a point which formed the covered member also on the glass substrate in addition to preparing a covered member between the feed through formed with silicon. In drawing 5 , the same sign is given to drawing 1 thru/or drawing 4 , and a common component, and detailed explanation is omitted. Moreover, in order to make a drawing legible, the component is omitted suitably.

[0046] In the case of the gyroscope 25 of the gestalt of this operation, as shown in drawing 5 , the detection-drive electric shielding wiring 26 (1st covered member) for covering between these electrodes 5 and 4 and between wiring 13 and 12 electrostatic is formed between the electrode 5 for detection of the inferior

surface of tongue of the top glass substrate 2, and the electrode 4 for a drive, and between the wiring 13 for detection, and the wiring 12 for a drive. This detection-drive electric shielding wiring 26 extends in the direction which crosses the top glass substrate 2, and both ends contact the detection-drive electric shielding section 19 located between the feed through 7 for a feed-through 8-drive for detection, and are connected electrically. Moreover, the detection-drive electric shielding wiring 26 is formed with the aluminum film, the chromium film, or platinum / titanium film as well as the electrode 5 for detection, the electrode 4 for a drive, the wiring 13 for detection, and the wiring 12 for a drive.

[0047] According to the configuration of the gestalt of this operation, when a frame part 11 is grounded at the time of use, the detection-drive electric shielding wiring 26 is also grounded by coincidence through the detection-drive electric shielding section 19. Therefore, between the feed through 7 for a feed-through 8-drive for detection is not only covered electrostatic, but between the electrodes 4 for an electrode 5-drive for detection formed with the metal thin film and between the wiring 12 for a wiring 13-drive for detection will be covered electrostatic like the gestalt of the 1st operation. Thereby, electrical noise is controlled further as a whole, and can aim at much more improvement in detection sensitivity.

[0048] The gestalt of operation of the 3rd of this invention is explained with reference to drawing 7 thru/or drawing 9 below [the gestalt of the 3rd operation]. The gestalt of this operation is the example applied to the pen mold mouse which is the example of the input unit which used the gyroscope of the gestalt of the 1st or the 2nd operation, and is specifically the coordinate input unit of a personal computer.

[0049] As the pen mold mouse 30 of the gestalt of this operation is shown in drawing 7 , two gyroscopes 32a and 32b as shown in the interior of the case 31 of a pen mold with the gestalt of the 1st or the 2nd operation are held. As shown in drawing 8 , when the pen mold mouse 30 is seen from a top, two gyroscopes 32a and 32b are arranged so that the extension direction of the foot of the tuning fork of each gyroscopes 32a and 32b may intersect perpendicularly (when it sees

from [of drawing 7] arrow-head A). Moreover, each gyroscopes 32a and 32b are driven, and the drive detector 33 for detecting an angle of rotation is formed. In addition, while a cell 34 is held in a case 31, it has the switch 36 grade of two switches 35a and 35b and a mouse body equivalent to the switch of a common mouse.

[0050] A user can move the cursor on a personal computer screen etc. according to the migration direction of a nib by having this pen mold mouse 30 and moving a nib towards desired. That is, if a nib is moved in accordance with X shaft orientations of the space 37 in drawing 7 , gyroscope 32b will detect an angle of rotation theta 1, and if it is made to move in accordance with Y shaft orientations of space 37, gyroscope 32a will detect an angle of rotation theta 2. When it is made to move in the other direction, it becomes the combination of an angle of rotation theta 1 and an angle of rotation theta 2. Therefore, in a personal computer side, the signal corresponding to an angle of rotation theta 1 and an angle of rotation theta 2 is received from the pen mold mouse 30, as shown in drawing 9 , X'shaft and Y' shaft on Screen 38 is made to correspond from the point before migration of the cursor 39 grade on Screen 38, and only the distance corresponding to the magnitude of angles of rotation theta1 and theta2 moves cursor 39. Thus, this pen mold mouse 30 can realize the same actuation as the common mouse which used the optical encoder etc.

[0051] Since it has the description of small, low driver voltage, and high sensitivity, the gyroscopes 32a and 32b of this invention used here can be used suitable for a small coordinate input device like the pen mold mouse 30 of the gestalt of this operation. Moreover, it is applicable to common input units which detect angular velocity, such as navigation and a head mount display.

[0052] In addition, the technical range of this invention can add various modification in the range which is not limited to the gestalt of the above-mentioned implementation and does not deviate from the meaning of this invention. For example, the number of the electrodes in the gyroscope of the gestalt of the above-mentioned operation may be set as arbitration. However, as

long as it is processible from the field of the improvement in sensibility, it is desirable to make [many] it. Moreover, the configuration and number of covered members which cover between inter-electrode or feed through are also arbitrary, and good. With the gestalt of the above-mentioned implementation, the covered member which covers inter-electrode for the covered member which covers between feed through with the same silicon as feed through was formed with the same metal thin film as an electrode material so that a manufacture process might not be complicated, but a different ingredient may be used as long as complication of a manufacture process is permissible. Moreover, although the gestalt of the above-mentioned implementation showed the example which used the tuning fork of a 3-piece mold, the number of feet can also be changed and one is sufficient.

[0053] Moreover, it is good also as a configuration which does not pinch the tuning fork which consists of silicon with two glass substrates, and does not have the glass substrate of one side. In this case, it becomes the gyroscope of simpler structure. Moreover, although the affinity of silicon and glass is good when the lamination by the anode plate conjugation method is taken into consideration, what welded glass to the front face of the base material of arbitration about the glass substrate can be substituted. Moreover, it is also possible to replace with silicon as an ingredient of a tuning fork, and to use carbon. In addition, the concrete publication of the ingredient of various configuration members, a configuration, etc. can be changed suitably, without restricting to the gestalt of the above-mentioned implementation.

[0054] Furthermore, although the example of a gyroscope was given with the gestalt of the above-mentioned implementation, this invention can apply an acceleration sensor, a pressure sensor, etc. to the electrostatic-capacity detection mold sensor of arbitration other than a gyroscope. In the sensor of the type for which the structures, such as a cantilever and diaphram, are made to exercise beforehand especially (vibration), by preparing a covered member peculiar to this invention between the inter-electrode one for electrode-detection

for a drive, or the track section for track section-detection for a drive connected to these electrodes, respectively, generating of the electrical noise by electrostatic induction is controlled, and improvement in a S/N ratio, as a result improvement in detection sensitivity can be realized.

[0055]

[Effect of the Invention] As mentioned above, since generating of the electrical noise by electrostatic induction is prevented by having prepared the covered member which covers between inter-electrode [these] or the track section electrostatic between the electrode for a drive, and the electrode for detection, or between the track section for a drive, and the track section for detection according to the electrostatic-capacity detection mold sensor and gyroscope of this invention as explained to the detail, improvement in a S/N ratio, as a result improvement in detection sensitivity can be aimed at. And it excelled in responsibility, for example, use of the gyroscope of this invention can realize an input unit with the small coordinate input unit of a personal computer etc.

[Translation done.]

* NOTICES *

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1.This document has been translated by computer. So the translation may not reflect the original precisely.

2.**** shows the word which can not be translated.

3.In the drawings, any words are not translated.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] It is the decomposition perspective view showing the gyroscope of the gestalt of operation of the 1st of this invention.

[Drawing 2] It is the perspective view showing the condition of having combined ****.

[Drawing 3] It is the sectional side elevation which meets the III-III line of drawing 2 .

[Drawing 4] It is the forward sectional view which meets the IV-IV line of drawing 2 .

[Drawing 5] It is the top view showing the gyroscope of the gestalt of operation of the 2nd of this invention.

[Drawing 6] (a) the mimetic diagram showing the configuration of the electrode takeoff connection of the conventional gyroscope, and the mimetic diagram showing the configuration of the electrode takeoff connection of the gyroscope of (b) this invention -- come out.

[Drawing 7] It is the perspective view showing the pen mold mouse which is the gestalt of operation of the 3rd of this invention.

[Drawing 8] It is the top view showing arrangement of two gyroscopes used for the **** pen mold mouse.

[Drawing 9] It is the front view showing the personal computer screen which operates it using a **** pen mold mouse.

[Drawing 10] It is the sectional view showing an example of the conventional electrostatic-capacity type acceleration sensor.

[Description of Notations]

1 25 Gyroscope

2 Top Glass Substrate (Base Material)

3 Bottom Glass Substrate (Base Material)

4 Electrode for Drive

5 Electrode for Detection

6 Tuning Fork

7 Feed through for Drive (Track Section for Drive)

8 Feed through for Detection (Track Section for Detection)

9 Foot (Oscillating Piece)

10 Supporter

11 Frame Part

12 Wiring for Drive (Track Section for Drive)

13 Wiring for Detection (Track Section for Detection)

19 Detection-Drive Electric Shielding Section (1st Covered Member)

20 Detection-Detection Electric Shielding Section (2nd Covered Member)

21 Drive-Drive Electric Shielding Section (2nd Covered Member)

26 Detection-Drive Electric Shielding Wiring (1st Covered Member)

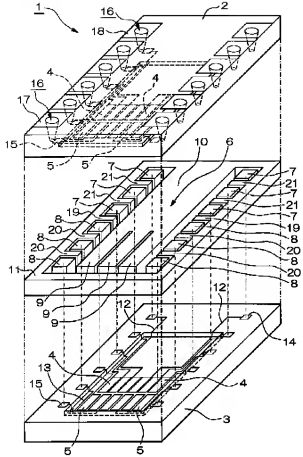
30 Pen Mold Mouse (Input Unit)

[Translation done.]

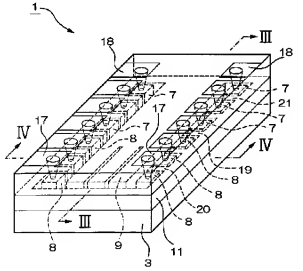
* NOTICES *

DRAWINGS

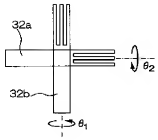
[Drawing 1]



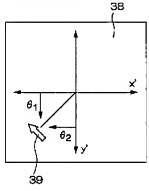
[Drawing 2]



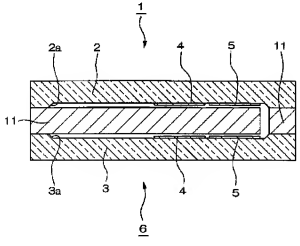
[Drawing 8]



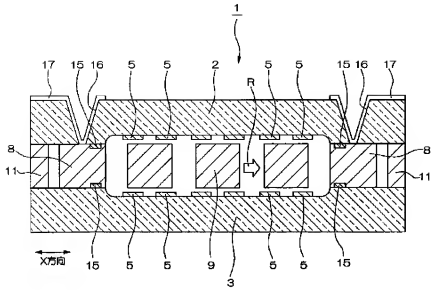
[Drawing 9]



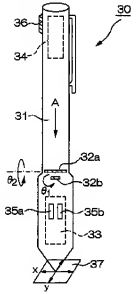
[Drawing 3]



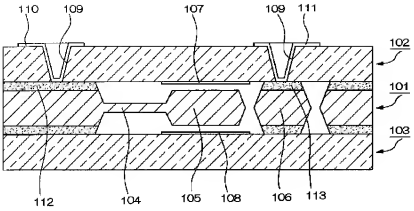
[Drawing 4]



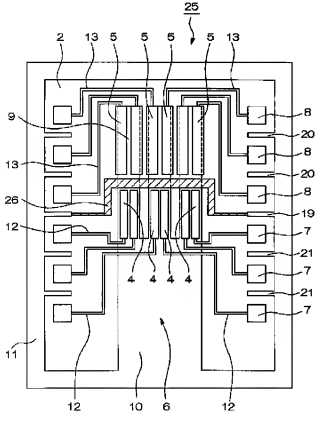
[Drawing 7]



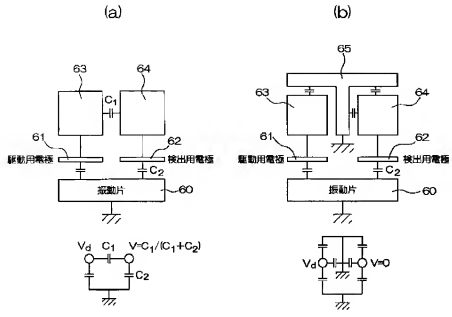
[Drawing 10]



[Drawing 5]



[Drawing 6]



[Translation done.]

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Ｇ０１Ｐ　9/04		Ｃ０１Ｐ　9/04		

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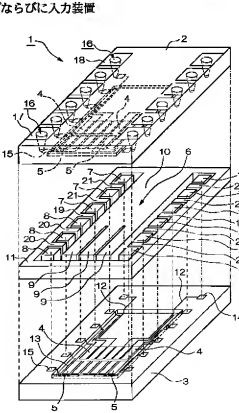
最終頁に続く

(54)【発明の名称】　静電容量検出型センサおよびジャイロスコープならびに入力装置

(57)【要約】
【課題】　電極周りで発生する電気的ノイズを抑制し、Ｓ／Ｎ比の向上によって検出感度の向上を図ることのできる静電容量検出型センサを提供する。
【解決手段】　本発明のジャイロスコープ１は、３本の脚９を有する音叉６と、両ガラス基板２，３上に設けられた駆動用電極４と検出用電極５と、駆動用電極４に駆動信号を供給する駆動用フィードスルー７と、検出用電極５からの検出信号を取り出す検出用フィードスルー８とを備えている。そして、駆動用フィードスルー７、検出用フィードスルー８が配列された隣接するフィードスルー間に、これらフィードスルー間を静電的に遮蔽する検出－駆動間遮蔽部１９、検出－検出間遮蔽部２０、駆動－駆動間遮蔽部２１がそれぞれ設けられている。



【特許請求の範囲】

【請求項１】　構造体と、該構造体を駆動する少なくとも一つの駆動用電極と、該駆動用電極に駆動信号を供給する少なくとも一つの駆動用線路部と、前記駆動用電極により駆動された前記構造体の変位を静電容量の変化に基づいて検出する少なくとも一つの検出用電極と、該検出用電極からの検出信号を伝送する少なくとも一つの検出用線路部とを備え、前記駆動用電極と前記検出用電極との間、もしくは前記駆動用線路部と前記検出用線路部との間に、これら電極間もしくは線路部間を静電的に遮蔽する遮蔽部材が設けられたことを特徴とする静電容量検出型センサ。

【請求項２】　振動片と、前記振動片と対向して設けられ、前記振動片を駆動する駆動用電極と、該駆動用電極に駆動信号を供給する駆動用線路部と、前記振動片と対向して設けられ、前記振動片の駆動方向と直交する方向の変位を検出する検出用電極と、該検出用電極からの検出信号を伝送する検出用線路部とを備え、前記駆動用電極と前記検出用電極との間、もしくは前記駆動用線路部と前記検出用線路部との間に、これら電極間もしくは線路部間を静電的に遮蔽する第１の遮蔽部材が設けられたことを特徴とするジャイロスコープ。

【請求項３】　前記振動片、前記駆動用線路部、前記検出用線路部および前記第１の遮蔽部材がともに同一平面上に形成されたことを特徴とする請求項２記載のジャイロスコープ。

【請求項４】　前記振動片、前記駆動用線路部、前記検出用線路部および前記第１の遮蔽部材がともに同じ導電性材料からなることを特徴とする請求項２または３記載のジャイロスコープ。

【請求項５】　前記駆動用電極と前記検出用電極とが前記振動片と対向して配置された基材上に設けられ、該基材上の前記駆動用電極と前記検出用電極との間、もしくは前記駆動用線路部と前記検出用線路部との間に、前記第１の遮蔽部材が設けられたことを特徴とする請求項２記載のジャイロスコープ。

【請求項６】　振動片と、前記振動片と対向して設けられ、前記振動片を駆動する駆動用電極と、該駆動用電極に駆動信号を供給する駆動用線路部と、前記振動片と対向して設けられ、前記振動片の駆動方向と直交する方向の変位を検出する検出用電極と、該検出用電極からの検出信号を伝送する検出用線路部とを備え、前記駆動用電極または前記検出用電極の少なくとも一方が互いに分離された複数の電極からなり、これら複数の電極の隣接する電極間、もしくは該隣接する電極にそれぞれ接続される線路部間に、これら電極間もしくは線路部間を静電的に遮蔽する第２の遮蔽部材が設けられたことを特徴とするジャイロスコープ。

【請求項７】　前記振動片、前記複数の電極にそれぞれ接続される線路部および前記第２の遮蔽部材がともに同一平面上に形成されたことを特徴とする請求項６記載のジャイロスコープ。

【請求項８】　前記振動片、前記複数の電極にそれぞれ接続される線路部および前記第２の遮蔽部材がともに同じ導電性材料からなることを特徴とする請求項６または７記載のジャイロスコープ。

【請求項９】　前記駆動用電極と前記検出用電極とが前記振動片と対向して配置された基材上に設けられ、前記基材上の前記複数の電極の隣接する電極間、もしくは該隣接する電極にそれぞれ接続される線路部間に、前記第２の遮蔽部材が設けられたことを特徴とする請求項６記載のジャイロスコープ。

【請求項１０】　前記導電性材料がシリコンであることを特徴とする請求項４または８記載のジャイロスコープ。

【請求項１１】　請求項２ないし１０のいずれか一項に記載のジャイロスコープを用いたことを特徴とする入力装置。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、静電容量検出型センサおよびジャイロスコープならびに入力装置に関し、特に静電容量検出型センサにおける外部取り出し電極周りの構成に関するものである。

【０００２】

【従来の技術】片持ち梁やダイヤフラムなどの構造体を有し、加速度や圧力等の所望の力学量を検出するセンサが従来から知られている。この種のセンサでは、外力が働いた際に生じる片持ち梁やダイヤフラムの変形量を静電容量の変化量として検出する方式が従来から採用されている。この種のセンサの一例として、静電容量式加速度センサの例を図１０に示す。

【０００３】図１０に示すセンサは、シリコン基板１０１とこれを挟持する２枚のガラス基板１０２，１０３から構成されている。シリコン基板１０１によって弾性部１０４（片持ち梁）、重錘１０５、導電柱１０６などが形成されており、弾性部１０４の先端に重錘１０５が加速度による慣性力を受けて変位可能に支持されている。また、各ガラス基板１０２，１０３上に重錘１０５と微小な間隙を介して対向する電極１０７，１０８がそれぞれ設けられており、重錘１０５が変位した際の重錘１０５－電極１０７，１０８間の静電容量の変化を検出信号として取り出すようになっている。両ガラス基板１０２，１０３とシリコン基板１０１とは陽極接合により気密状態に接合されているが、センサ内部の重錘１０５や電極１０７，１０８との電気的導通を取る必要があるため、上側ガラス基板１０２に孔１０９が形成され、各孔１０９の表面には外部回路に接続するためのアルミニウムからなる導電層１１０，１１１が形成されている。導電層１１０は不純物層１１２を介して重錘１０５と電気

的に接続され、導電層１１１は不純物層１１３を介して導電柱１０６と電気的に接続されている。さらに、導電柱１０６は電極１０７，１０８と電気的に接続されている。

【０００４】この種のセンサは、マイクロマシニング技術を用いたマイクロセンサとして実現される。その場合、片持ち梁やダイヤフラム等の構造体にシリコン基板が用いられ、これを挟持する支持体にはガラス基板が用いられることが多い。シリコン基板は半導体製造技術を用いて微細加工が可能な材料であるし、ガラス基板は陽極接合法を用いてシリコン基板と容易に接合可能な材料だからである。また、シリコン基板の両面をガラス基板で封止することによって、センサのパッケージを構成することにもなる。この構成を採用した場合、上述したように、パッケージ内に封入されたシリコンからなる構造体や電極との導通を取るために、ガラス基板に開けた孔に形成した導電体、シリコン基板で形成した導電柱、いわゆるフィードスルーと呼ばれる電気信号の取り出し部などが必要になる。

【０００５】

【発明が解決しようとする課題】ところが、上記従来の静電容量検出型センサには、検出信号として電気信号を外部に取り出す際に電気的ノイズが発生し、Ｓ／Ｎ比が劣化して検出感度が低下する、という問題があった。

【０００６】これは、外力が働く前に片持ち梁やダイヤフラムを予め運動（振動）させておくタイプのセンサの場合、特に顕著な問題となる。なぜならば、この種のセンサは、検出用電極に加えて、片持ち梁やダイヤフラムを駆動するための駆動用電極を有している。ところが、マイクロセンサの場合、微小寸法の中に検出用電極と駆動用電極が近接して形成されることが多く、検出用電極と駆動用電極が容量結合された状態となっている。そのため、駆動用電極に駆動信号を供給した際に、その信号の影響を受けて検出用電極に不要の電圧が誘導され、電気的ノイズが発生するからである。さらに、上記の例のように、フィードスルーにより検出信号を取り出す場合には、駆動用、検出用各々のフィードスルー間の寄生容量という形でも電気的ノイズが発生する。

【０００７】このように駆動用電極と検出用電極を兼備したセンサの例として、導電性を有するシリコン等の材料からなる音叉を用いたジャイロスコープが知られている。このジャイロスコープは、音叉の脚を一方向に振動（駆動）させ、振動中に脚の長手方向を中心軸とする角速度が入力された際にコリオリ力によって生じる前記振動方向と垂直な方向の振動を検出するものである。コリオリ力により生じる振動の大きさは角速度の大きさに対応するので、このジャイロスコープを角速度センサとして用いることができ、例えばパソコンの座標入力装置等に適用することができる。

【０００８】このジャイロスコープにおいては、検出感度向上のために様々な工夫がなされてきたが、検出感度のより一層の向上が望まれている。検出感度のさらなる向上を実現するには、ジャイロスコープにおいても上記電気的ノイズの問題を避けて通ることはできない。また、各種センサの微細化がますます進んでいる現状を考えると、センサの駆動や検出の方式によっては、前述の駆動用電極－検出用電極間のみならず、駆動用電極－駆動用電極間、あるいは検出用電極－検出用電極間の容量結合による電気的ノイズの発生も無視できなくなると考えられる。

【０００９】本発明は、上記の課題を解決するためになされたものであって、センサ内の電極周りで発生する電気的ノイズを極力抑制し、Ｓ／Ｎ比の向上によって検出感度の向上を図ることのできる静電容量検出型センサおよびジャイロスコープ、ならびにこのジャイロスコープを利用した入力装置の提供を目的とする。

【００１０】

【課題を解決するための手段】上記の目的を達成するために、本発明の静電容量検出型センサは、構造体と、該構造体を駆動する少なくとも一つの駆動用電極と、該駆動用電極に駆動信号を供給する少なくとも一つの駆動用線路部と、前記駆動用電極により駆動された前記構造体の変位を静電容量の変化に基づいて検出する少なくとも一つの検出用電極と、該検出用電極からの検出信号を伝送する少なくとも一つの検出用線路部とを備え、前記駆動用電極と前記検出用電極との間、もしくは前記駆動用線路部と前記検出用線路部との間に、これら電極間もしくは線路部間を静電的に遮蔽する遮蔽部材が設けられたことを特徴とする。

【００１１】本発明のジャイロスコープは、振動片と、前記振動片と対向して設けられ、前記振動片を駆動する駆動用電極と、該駆動用電極に駆動信号を供給する駆動用線路部と、前記振動片と対向して設けられ、前記振動片の駆動方向と直交する方向の変位を検出する検出用電極と、該検出用電極からの検出信号を伝送する検出用線路部とを備え、前記駆動用電極と前記検出用電極との間、もしくは前記駆動用線路部と前記検出用線路部との間に、これら電極間もしくは線路部間を静電的に遮蔽する第１の遮蔽部材が設けられたことを特徴とする。

【００１２】本発明において、「駆動用線路部」、「検出用線路部」という際の「線路部」とは、駆動用電極、検出用電極等の電極と電気的に接続され、これら電極との間で信号をやり取りする伝送路となる部分全体を示している。よって、従来の技術の項で述べた「シリコンで形成したフィードスルー」などは、本発明の「線路部」に含まれる。

【００１３】ここで、フィードスルーを有するジャイロスコープを例に挙げて、本発明の作用・効果を説明する。図６（ａ）は従来のジャイロスコープの構成を示す模式図である。振動片６０（音叉の脚に相当）と微小な

間隙を介して駆動用電極６１、検出用電極６２が配置されており、駆動用電極６１に駆動信号を供給するための駆動用フィードスルー６３と、検出用電極６２から検出信号を取り出すための検出用フィードスルー６４とが各電極６１，６２にそれぞれ接続されている。駆動用フィードスルー６３と検出用フィードスルー６４とは容量結合しており、その容量値をＣ１とする。また、振動片６０と検出用電極６２との間でも容量が形成され、その容量値をＣ２とする。

【００１４】このジャイロスコープにおいて、駆動用フィードスルー６３に駆動電圧（Ｖdrive）としてＶdrive＝Ｖｄを印加すると、振動片６０が変位していない状態での検出用フィードスルー６４からの検出電圧（Ｖdetect）は本来、Ｖdetect＝０であるにもかかわらず、

Ｖdetect＝{Ｃ１／（Ｃ１＋Ｃ２）}・Ｖｄ　…（１）

なる電圧が誘導され、これが検出信号を検出する際のノイズとなってしまう。

【００１５】そこで、このノイズの発生を抑制するには、駆動用フィードスルーと検出用フィードスルーとの間に遮蔽部材を挿入すればよい。図６（ｂ）は本発明のジャイロスコープの構成を示す模式図である。この構成の場合、駆動用フィードスルー６３と検出用フィードスルー６４との間に遮蔽部材６５が設けられ、遮蔽部材６５が接地されたことにより、駆動用フィードスルー６３と検出用フィードスルー６４が電気的に隔離された状態となる。その結果、駆動用フィードスルー６３にＶdrive＝Ｖｄを印加しても、検出用フィードスルー６４側ではＶdetect＝０が実現され、ノイズの発生を抑制することができる。

【００１６】このように、本発明の静電容量検出型センサにおいては、駆動用電極と検出用電極との間、もしくは駆動用線路部と検出用線路部との間に、これら電極間もしくは線路部間を静電的に遮蔽する遮蔽部材を設けたことにより、静電誘導による電気的ノイズの発生が防止されるので、Ｓ／Ｎ比が向上することによって検出感度の向上を図ることができる。同様に、本発明のジャイロスコープにおいては、駆動用電極と検出用電極との間、もしくは駆動用線路部と検出用線路部との間に、これら電極間もしくは線路部間を静電的に遮蔽する第１の遮蔽部材を設けたことにより、電気的ノイズの発生が防止されるので、Ｓ／Ｎ比が向上することによって角速度の検出感度の向上を図ることができる。

【００１７】本発明のジャイロスコープの具体的な構成としては、振動片、駆動用線路部、検出用線路部および第１の遮蔽部材をともに同一平面上に形成することができる。また、これら全ての部材を同じ導電性材料で形成することができる。より具体的には、半導体製造技術を用いて微細加工が容易なシリコン等の半導体基板に導電性を付与したものを材料とし、これをフォトリソグラフィー、エッチング技術により加工することにより、振動片、駆動用線路部、検出用線路部および第１の遮蔽部材を１枚の半導体基板から作り込むことができる。この構成とすれば、特に製造プロセスを複雑にすることなく、本発明の構成を実現することができる。

【００１８】あるいは、駆動用電極と検出用電極を振動片と対向して配置した基材上に設けた場合、基材上の駆動用電極と検出用電極との間、または駆動用線路部と検出用線路部との間に前記第１の遮蔽部材を設けるようにしても良い。すなわち、上では第１の遮蔽部材を振動片と同じシリコンから形成する例を述べたが、駆動用電極と検出用電極を上記基材上に設ける場合、駆動用電極と検出用電極、並びにこれら電極に接続される線路部（配線）は、具体的には金属薄膜等を用いて基材上に形成されることになる。その場合、第１の遮蔽部材にも金属薄膜等を用い、これを基材上の駆動用電極と検出用電極との間、駆動用線路部と検出用線路部との間に設けるようにすれば、やはりこれら電極間もしくは線路部間を遮蔽することができ、上記と同様の作用・効果を得ることができる。

【００１９】また、本発明の他のジャイロスコープは、振動片と、前記振動片と対向して設けられ、前記振動片を駆動する駆動用電極と、該駆動用電極に駆動信号を供給する駆動用線路部と、前記振動片と対向して設けられ、前記振動片の駆動方向と直交する方向の変位を検出する検出用電極と、該検出用電極からの検出信号を伝送する検出用線路部とを備え、前記駆動用電極または前記検出用電極の少なくとも一方が互いに分離された複数の電極からなり、これら複数の電極の隣接する電極間、もしくは該隣接する電極にそれぞれ接続される線路部間に、これら電極間もしくは線路部間を静電的に遮蔽する第２の遮蔽部材が設けられたことを特徴とする。

【００２０】上述したように、電気的ノイズの抑制に関しては、駆動用電極と検出用電極との間、もしくは駆動用線路部と検出用線路部との間を遮蔽するのが最も効果的である。しかしながら、ジャイロスコープの構成、駆動や検出の方式によっては、駆動－駆動間、検出－検出間を遮蔽すると、ノイズの発生をさらに抑制できる場合もある。例えば、検出用電極が唯一つの電極で構成されるのではなく、互いに分離された複数の電極から構成され、しかもこれら複数の電極が、振動片が一方向に変位した際に容量変化が正になる電極と負になる電極に割り振られ、これら電極間で差動検出を行うタイプのジャイロスコープの場合、上記容量変化が正になる電極と負になる電極が隣接していると、一方の電極の検出電圧が他方の電極の検出電圧の影響を受けて変動することなども考えられる。このような場合、隣接する検出用電極間もしくは検出用線路部間を静電的に遮蔽する第２の遮蔽部材を設けることにより、隣接する電極や線路部からの影響をなくし、検出精度の向上を図ることができる。

【００２１】駆動－駆動間、検出－検出間を遮蔽する第

2の遮蔽部材に関しても、上述した第1の遮蔽部材と同様、振動片、複数の電極にそれぞれ接続される線路部および第2の遮蔽部材をともに同一平面上に形成することができる。また、これら部材を同じ導電性材料で形成することができる。この構成によっても、上述した第1の遮蔽部材の場合と同様の作用・効果を得ることができる。

【0022】また、駆動用電極と検出用電極とを振動片と対向して配置した基材上に設けた場合、基材上の複数の電極の隣接する電極間、もしくは隣接する電極にそれぞれ接続される線路部間に、前記第2の遮蔽部材を設けても良い。この点に関しても、第1の遮蔽部材の場合と全く同様である。

【0023】本発明の入力装置は、上記本発明のジャイロスコープを用いたことを特徴とするものである。本発明によれば、検出感度の高い本発明のジャイロスコープを用いたことにより、応答性に優れた入力装置を実現することができる。

【0024】

【発明の実施の形態】〔第1の実施の形態〕以下、本発明の第1の実施の形態を図1ないし図4を参照して説明する。図1は本実施の形態のジャイロスコープの全体構成を示す分解斜視図、図2は各部材を組み合わせた状態を示す斜視図、図3は図2のIII－III線に沿う断面図、図4は図2のIV－IV線に沿う断面図、である。図中符号2は上側ガラス基板（基材）、3は下側ガラス基板（基材）、4は駆動用電極、5は検出用電極、6は音叉、7は駆動用フィードスルー（駆動用線路部）、8は検出用フィードスルー（検出用線路部）、である。なお、図面を見やすくするため、図面によって構成要素を適宜省略してある。

【0025】本実施の形態のジャイロスコープ1は、図1および図2に示すように、3本の脚9（振動片）とこれらの基端側を連結する支持部10とを有する3脚型の音叉6が用いられている。また、音叉6の周囲を囲むように枠部11が設けられており、これら音叉6と枠部11とは、元々は厚さ200μm程度の導電性を有する1枚のシリコン基板から形成されている。図3に示すように、枠部11は上側ガラス基板2と下側ガラス基板3との間に挟持されて固定されるとともに、2枚のガラス基板2，3の内面のうち、音叉6の上方および下方に位置する領域は10μm程度の深さの凹部2a，3aとなっており、各ガラス基板2，3と音叉6との間に10μm程度の間隙が形成されることで音叉6の各脚9が宙に浮いた状態となり、振動可能となっている。

【0026】両ガラス基板2，3と枠部11とは、ガラスとシリコンの陽極接合により接合されている。したがって、両ガラス基板2，3と枠部11とによって気密状態に保持された空間内に音叉6が配置されることになる。さらに、両ガラス基板2，3は、本ジャイロスコープ1のパッケージの役目も果たしている。

【0027】図1および図2に示すように、上側ガラス基板2下面の凹部2a内の脚9の基端側と対向する位置には、各脚9に2個ずつ、計6個の駆動用電極4が脚9の長手方向に延在して設けられている。駆動用電極4は膜厚300nm程度のアルミニウム膜またはクロム膜、もしくは膜厚30nm程度のチタン膜上に膜厚70nm程度の白金膜を積層した膜（以下、白金／チタン膜と記す）等から形成されており、駆動用電極4に駆動信号を供給するための駆動用配線12が電極と同じレイヤーのアルミニウム膜またはクロム膜、もしくは白金／チタン膜等により一体的に形成されている。また、上記駆動用電極4よりも脚9の先端側に対向する位置には、各脚9に2個ずつ、計6個の検出用電極5が脚9の長手方向に延在して設けられている。この検出用電極5も駆動用電極4と同じ材料で形成され、各検出用電極5に連続して検出用配線13がそれぞれ形成されている。さらに、上側ガラス基板2下面の凹部2aの外側に位置する部分において、駆動用配線12および検出用配線13の先端に同一の金属薄膜からなる中間パッド部14，15が設けられている。

【0028】また、駆動用電極4、検出用電極5、およびこれら電極4，5に接続された駆動用配線12、検出用配線13の構成は、上で説明した上側ガラス基板2と下側ガラス基板3とで全く同様である。

【0029】図1および図2に示すように、音叉6と枠部11は一体に形成されているが、音叉6の両側方には、音叉6と枠部11から孤立したアイランド状のシリコン片からなる駆動用フィードスルー7、検出用フィードスルー8が音叉6の長手方向に沿って6個ずつ、計12個設けられている。1列6個のフィードスルーのうち、脚9の先端側に位置する3個のフィードスルーが検出用フィードスルー8、脚9の基端側に位置する3個のフィードスルーが駆動用フィードスルー7に対応している。

【0030】そして、図1および図2におけるジャイロスコープ1を正面から見たとき、左列の3個の検出用フィードスルー8は左側3個の検出用電極5の信号取り出し用に割り当てられており、手前側から奥側に向けての各検出用フィードスルー8が中央側から左端に向けての各検出用電極5に対応している。一方、左列の3個の駆動用フィードスルー7も左側3個の駆動用電極4への信号供給用に割り当てられているが、手前側から奥側に向けての各駆動用フィードスルー7が左端から中央側に向けての駆動用電極4に対応している。同様に、右列の検出用フィードスルー8および駆動用フィードスルー7は右側の検出用電極5および駆動用電極4にそれぞれ割り当てられている。これらフィードスルー7，8は、音叉6や枠部11から孤立してはいるが、同一のシリコン基板から形成されており、音叉6や枠部11と同様、導電

性を有している。

【００３１】両ガラス基板２，３上の検出用配線１３、駆動用配線１２と検出用フィードスルー８、駆動用フィードスルー７の接続関係を図４を用いて説明する。なお、ここでは検出側を例に挙げて説明するが、駆動側も全く同様の構成である。図４に示すように、下側ガラス基板３の上面および上側ガラス基板２の下面に検出用配線１３に繋がる中間パッド部１５がそれぞれ形成され、中間パッド部１５の形成位置に検出用フィードスルー８が接合されている。そして、上側ガラス基板２の検出用フィードスルー８に対応する位置にテーパ状のスルーホール１６が形成され、スルーホール１６の内面に沿って形成された導電膜が上側ガラス基板２の上面に延在し、外部接続用パッド部１７となっている。この導電膜は、例えば下層側に膜厚５０ｎｍ程度のクロム、上層側に膜厚１０００ｎｍ程度の金を積層した２層構造の膜である。よって、ジャイロスコープ１を平面視した際に同一位置にある検出用電極５から延びる２つの中間パッド部１５と検出用フィードスルー８とが電気的に接続され、検出用フィードスルー８と外部接続用パッド部１７とがスルーホール１６内で接続することにより電気的に接続されている。また、外部接続用パッド部１７はワイヤボンディング等の手段により外部回路（図示せず）と接続され、検出信号は、検出用電極５、検出用フィードスルー８、外部接続用パッド部１７の経路を経て外部回路に取り出される。なお、図１および図２中の符号１８は、駆動用電極４と電気的に接続された外部接続用パッド部である。

【００３２】図４に示すように、各脚９に対して、各ガラス基板２，３で２個ずつ、計４個の検出用電極５が対向配置されているが、１枚のガラス基板上の２個の検出用電極５の各々の外端と脚９の変位検出方向（図における Ｘ方向）の端部同士が完全に揃うように対向配置されているわけではなく、各検出用電極５の外端と脚９の端部が、脚９の変位検出方向の最大振幅以上の距離だけずれた状態に配置されている。また、各検出用電極５の幅は、脚９の最大振幅以上の寸法に設定されている。この構成によれば、脚９が紙面右方向（矢印Ｒの方向）に変位した際には、脚９の右側にはみ出した検出用電極５側では対向面積が増えるために容量変化が正となり、脚９の左側にはみ出した検出用電極５側では対向面積が減るために容量変化が負となる。したがって、これらの容量変化量を別々に検出して差動検出を行うことができる。この場合、２つの容量値における初期容量値が互いに等しいため、差分をとると初期容量値分が消去され、容量変化量のみが残る。したがって、初期容量値の中に含まれるノイズ成分をキャンセルすることができ、検出精度を向上させることができる。

【００３３】図１および図２に示すように、駆動用フィードスルー７、検出用フィードスルー８が配列された部分には、隣接するフィードスルー７，８間に位置する壁部がそれぞれ形成されている。これら壁部は枠部１１と一体に形成されている。片側の列で６個のフィードスルーの間に５個の壁部が設けられているが、５個の壁部のうち、中央の壁部は、隣接する検出用フィードスルー８と駆動用フィードスルー７との間を静電的に遮蔽する役目を果たしており、検出－駆動間遮蔽部１９（第１の遮蔽部材）を構成している。手前側２個の壁部は、隣接する検出用フィードスルー８間を静電的に遮蔽する役目を果たしており、検出－検出間遮蔽部２０（第２の遮蔽部材）を構成している。奥側２個の壁部は、隣接する駆動用フィードスルー７間を静電的に遮蔽する役目を果たしており、駆動－駆動間遮蔽部２１（第２の遮蔽部材）を構成している。

【００３４】さらに、ジャイロスコープ１の機能上は特に必要ではなく、後述する製造上の都合により必要なものであるため、図示を省略するが、実際には、検出用電極５および検出用配線１３、駆動用電極４および駆動用配線１２の形成領域以外の上側ガラス基板２の下面側、および下側ガラス基板３の上面側に、これら電極および配線と同一のアルミニウム膜またはクロム膜、もしくは白金／チタン膜等からなる同電位パターンが設けられている。

【００３５】上記構成のジャイロスコープ１を製造する際には、まずガラス基板を用意し、マスク材を用いてガラス基板のフッ酸エッチングを行い、ガラス基板上の音叉６の位置に対応する領域に凹部２ａ，３ａを形成する。その後、凹部２ａ，３ａを形成した面に金属膜を成膜した後、フォトリソグラフィー、エッチング技術を用いてパターニングすることにより、検出用電極５、検出用配線１３、駆動用電極４、駆動用配線１２および同電位パターンを形成する。以上の工程により、下側ガラス基板３が完成する。上側ガラス基板２に関しては、さらにスルーホール１６も形成し、金属膜の成膜、パターニングにより外部接続用パッド部１７，１８を形成する。

【００３６】次にシリコン基板を用意し、シリコン基板の下面と下側ガラス基板３とを陽極接合法を用いて接合する。この際、シリコン基板のうち、後で枠部１１となる部分が接合されるようにする。陽極接合法ではシリコン基板に正、ガラス基板に負の電位を印加してシリコンとガラスを容易に接合することができるが、シリコン基板が音叉６となる部分では下側ガラス基板３表面との間隙が１０μｍ程度しかないため、陽極接合時の静電引力によりシリコン基板が撓んで下側ガラス基板３と接触すると、その部分も接合されてしまい、振動可能な音叉を形成できなくなる。したがって、下側ガラス基板３に接合すべきでない部分が接合されてしまうのを防止する目的で下側ガラス基板３のその部分をシリコン基板と同電位とするために、下側ガラス基板３表面に同電位パターンを形成しておく。この点は上側ガラス基板２について

も同様である。

【００３７】次に、シリコン基板表面に、音叉６、枠部１１、検出用フィードスルー８、駆動用フィードスルー７等、シリコンを残す部分の形状を有するレジストパターンを形成し、反応性イオンエッチング等の異方性エッチングを用いてシリコン基板を貫通するエッチングを行う。これにより、音叉６、枠部１１、検出用フィードスルー８、駆動用フィードスルー７等が形成され、音叉６の部分は下側ガラス基板３の上方で宙に浮いた状態となる。その後、レジストパターンを剥離する。

【００３８】次に、下側ガラス基板３に接合されたシリコン基板の上面と上側ガラス基板２とを陽極接合法を用いて接合する。この際も、枠部１１が上側ガラス基板２に接合されることになる。以上の工程により、本実施の形態のジャイロスコープ１が完成する。

【００３９】本実施の形態のジャイロスコープ１を使用する際には、枠部１１を接地するとともに、駆動用電極４側の外部接続用パッド部１８に接続された外部配線に駆動源としての発振器を接続する。この際、枠部１１、音叉６、検出－駆動間遮蔽部１９、検出－検出間遮蔽部２０、駆動－駆動間遮蔽部２１は全て一体であるから同電位となり、枠部１１を接地すれば、音叉６、検出－駆動間遮蔽部１９、検出－検出間遮蔽部２０、駆動－駆動間遮蔽部２１は全て接地された状態となる。また、図４において各脚９の右側には み出した検出用電極５の外部接続用パッド部１７に接続された外部配線と音叉６との間に第１の容量検出器を接続するとともに、各脚９の左側にはみ出した検出用電極５の外部接続用パッド部１７に接続された外部配線と音叉６との間に第２の容量検出器を接続する。

【００４０】そこで、発振器を駆動して音叉６－駆動用電極４間に数ｋＨｚ程度の周波数の駆動信号を印加すると、音叉６の各脚９が鉛直方向に振動する。その状態で、脚９の長手方向を回転軸とする角速度が入力されると、入力された角速度の大きさに応じた水平方向の振動が生じる。この時、音叉６の各脚９と検出用電極５とが対向した状態にあり、脚９の水平振動に伴って各脚９と各検出用電極５の対向面積が変化するため、容量変化が生じる。この時の容量変化量を第１の容量検出器および第２の容量検出器で差動検出することにより角速度の大きさを検出することができる。

【００４１】本実施の形態のジャイロスコープ１においては、駆動用フィードスルー７と検出用フィードスルー８との間に検出－駆動間遮蔽部１９を設けたことにより、これらフィードスルー７，８間が静電的に遮蔽されるので、駆動信号の印加により検出用フィードスルー８に誘導される電気的ノイズが抑制されるので、Ｓ／Ｎ比が向上することによって角速度の検出感度の向上を図ることができる。

【００４２】さらに、本実施の形態のジャイロスコープ１の場合、差動検出を行っており、隣接する検出用フィードスルー８から異なる検出信号が取り出されるため、隣接するフィードスルーの信号の影響を受けて検出信号が変動する恐れがある。その点、隣接する検出用フィードスルー８にも検出－検出間遮蔽部２０を設けたことによって、隣接する検出用フィードスルー８からの影響が排除され、検出精度の向上を図ることができる。

【００４３】また、音叉６、枠部１１、駆動用フィードスルー７、検出用フィードスルー８、検出－駆動間遮蔽部１９、検出－検出間遮蔽部２０、駆動－駆動間遮蔽部２１が全て１枚のシリコン基板から形成されているため、特に製造プロセスを複雑にすることなく、一般のシリコン加工技術を用いて本実施の形態の構成を実現することができる。

【００４４】また、本実施の形態のジャイロスコープ１は、音叉６が２枚のガラス基板２，３の間に挟持されているため、ガラス基板２，３によって音叉６の部分が保護され、取り扱いやすいものとなっている。さらに、音叉６の部分に塵埃が入りにくい構造であるから、外乱が抑制され、センサ精度を向上することができる。また、真空封止も行える構造であり、これによればＱ値（共振の大きさを表す性能指数）の向上を図ることができ、デバイスに供給する電気エネルギーから振動エネルギーへの変換効率が向上するため、駆動電圧の低減を図ることができる。

【００４５】［第２の実施の形態］以下、本発明の第２の実施の形態を図５を参照して説明する。図７は本実施の形態のジャイロスコープの全体構成を示す平面図である。本実施の形態のジャイロスコープの基本構成は第１の実施の形態と同様であるが、本実施の形態のジャイロスコープが第１の実施の形態と異なる点は、シリコンで形成したフィードスルー間に遮蔽部材を設けることに加えて、ガラス基板上にも遮蔽部材を形成した点である。図５では、図１ないし図４と共通の構成要素に同一の符号を付し、詳細な説明は省略する。また、図面を見やすくするため、構成要素を適宜省略してある。

【００４６】本実施の形態のジャイロスコープ２５の場合、図５に示すように、上側ガラス基板２の下面の検出用電極５と駆動用電極４との間、および検出用配線１３と駆動用配線１２との間に、これら電極５，４間および配線１３，１２間を静電的に遮蔽するための検出－駆動間遮蔽配線２６（第１の遮蔽部材）が設けられている。この検出－駆動間遮蔽配線２６は上側ガラス基板２を横断する方向に延在し、両端部は検出用フィードスルー８－駆動用フィードスルー７間に位置する検出－駆動間遮蔽部１９と接触し、電気的に接続されている。また、検出－駆動間遮蔽配線２６は、検出用電極５、駆動用電極４、検出用配線１３、駆動用配線１２と同様、アルミニウム膜またはクロム膜、もしくは白金／チタン膜等により形成されている。

【００４７】本実施の形態の構成によれば、使用時に枠部１１を接地した際に検出－駆動間遮蔽部１９を通じて検出－駆動間遮蔽配線２６も同時に接地される。したがって、第１の実施の形態のように、検出用フィードスルー８－駆動用フィードスルー７間が静電的に遮蔽されるのみならず、金属薄膜で形成した検出用電極５－駆動用電極４間、および検出用配線１３－駆動用配線１２間も静電的に遮蔽されることになる。これにより、電気的ノイズが全体としてさらに抑制され、検出感度のより一層の向上を図ることができる。

【００４８】［第３の実施の形態］以下、本発明の第３の実施の形態を図７ないし図９を参照して説明する。本実施の形態は第１または第２の実施の形態のジャイロスコープを用いた入力装置の例であり、具体的にはパソコンの座標入力装置であるペン型マウスに適用した例である。

【００４９】本実施の形態のペン型マウス３０は、図７に示すように、ペン型のケース３１の内部に第１または第２の実施の形態で示したようなジャイロスコープ３２ａ、３２ｂが２個収容されている。２個のジャイロスコープ３２ａ、３２ｂは、図８に示すように、ペン型マウス３０を上から見たとき（図７の矢印Ａ方向から見たとき）に各ジャイロスコープ３２ａ、３２ｂの音叉の脚の延在方向が直交するように配置されている。また、各ジャイロスコープ３２ａ、３２ｂを駆動し、回転角を検出するための駆動検出回路３３が設けられている。その他、ケース３１内に電池３４が収容されるとともに、一般のマウスのスイッチに相当する２つのスイッチ３５ａ、３５ｂ、マウス本体のスイッチ３６等が備えられている。

【００５０】使用者は、このペン型マウス３０を持ち、所望の方向にペン先を移動させることによって、パソコン画面上のカーソル等をペン先の移動方向に応じて動かすことができる。すなわち、ペン先を図７中の紙面３７のＸ軸方向に沿って移動させると、ジャイロスコープ３２ｂが回転角θ１を検出し、紙面３７のＹ軸方向に沿って移動させると、ジャイロスコープ３２ａが回転角θ２を検出する。それ以外の方向に移動させた場合には回転角θ１と回転角θ２の組み合わせとなる。したがって、パソコン側では回転角θ１および回転角θ２に対応した信号をペン型マウス３０から受け取って、図９に示すように、画面３８上のカーソル３９等の移動前の点から画面３８上でのＸ’軸、Ｙ’軸に対応させて回転角θ１、θ２の大きさに対応する距離だけカーソル３９を移動させる。このようにして、このペン型マウス３０は、光学式エンコーダ等を用いた一般のマウスと同様の動作を実現することができる。

【００５１】ここで用いた本発明のジャイロスコープ３２ａ、３２ｂは、小型、低駆動電圧、高感度という特徴を持っているため、本実施の形態のペン型マウス３０のような小型の座標入力機器に好適に使用することができる。また、ナビゲーションやヘッドマウントディスプレイなど、角速度を検知する一般の入力装置に応用が可能である。

【００５２】なお、本発明の技術範囲は上記実施の形態に限定されるものではなく、本発明の趣旨を逸脱しない範囲において種々の変更を加えることが可能である。例えば上記の実施の形態のジャイロスコープにおける電極の数は任意に設定してかまわない。しかしながら、感度向上の面からは、加工が可能である限り、多くすることが望ましい。また、電極間またはフィードスルー間を遮蔽する遮蔽部材の形状や数も任意でよい。上記実施の形態では、製造プロセスが複雑化しないようにフィードスルー間を遮蔽する遮蔽部材をフィードスルーと同じシリコンで、電極間を遮蔽する遮蔽部材を電極材料と同じ金属薄膜で形成したが、製造プロセスの複雑化が許容できるのであれば、異なる材料を用いても良い。また、上記実施の形態では３脚型の音叉を用いた例を示したが、脚の数も変更が可能であり、１本でも良い。

【００５３】また、シリコンからなる音叉を２枚のガラス基板で挟持するのではなく、片側のガラス基板がない構成としてもよい。この場合、より簡易な構造のジャイロスコープとなる。また、陽極接合法による張り合わせを考慮すると、シリコンとガラスの相性がよいが、ガラス基板に関しては任意の基材の表面にガラスを融着したものでも代用できる。また、音叉の材料としてシリコンに代えて、カーボンを用いることも可能である。その他、各種構成部材の材料、形状等の具体的な記載は上記実施の形態に限ることなく、適宜変更が可能である。

【００５４】さらに、上記実施の形態ではジャイロスコープの例を挙げたが、本発明は、例えば加速度センサ、圧力センサ等、ジャイロスコープ以外の任意の静電容量検出型センサに適用が可能である。特に片持ち梁やダイヤフラム等の構造体を予め運動（振動）させておくタイプのセンサにおいて、駆動用電極－検出用電極間、もしくはこれら電極にそれぞれ接続された駆動用線路部－検出用線路部間に、本発明特有の遮蔽部材を設けることにより、静電誘導による電気的ノイズの発生が抑制され、Ｓ／Ｎ比の向上、ひいては検出感度の向上を実現することができる。

【００５５】

【発明の効果】以上、詳細に説明したように、本発明の静電容量検出型センサおよびジャイロスコープによれば、駆動用電極と検出用電極との間、もしくは駆動用線路部と検出用線路部との間にこれら電極間もしくは線路部間を静電的に遮蔽する遮蔽部材を設けたことによって、静電誘導による電気的ノイズの発生が防止されるので、Ｓ／Ｎ比の向上、ひいては検出感度の向上を図ることができる。そして、本発明のジャイロスコープの使用により、応答性に優れた、例えばパソコンの座標入力装

置等の小型の入力装置を実現することができる。

【図面の簡単な説明】

【図１】　本発明の第１の実施の形態のジャイロスコープを示す分解斜視図である。

【図２】　同、組み合わせた状態を示す斜視図である。

【図３】　図２のIII－III線に沿う側断面図である。

【図４】　図２のIV－IV線に沿う正断面図である。

【図５】　本発明の第２の実施の形態のジャイロスコープを示す平面図である。

【図６】　（ａ）従来のジャイロスコープの電極取り出し部の構成を示す模式図、（ｂ）本発明のジャイロスコープの電極取り出し部の構成を示す模式図、である。

【図７】　本発明の第３の実施の形態であるペン型マウスを示す斜視図である。

【図８】　同、ペン型マウスに用いた２個のジャイロスコープの配置を示す平面図である。

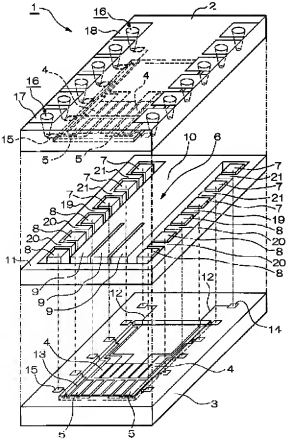
【図９】　同、ペン型マウスを用いて操作を行うパソコン画面を示す正面図である。

【図１０】　従来の静電容量式加速度センサの一例を示す断面図である。

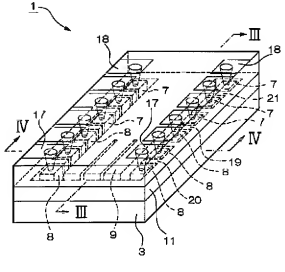
【符号の説明】

１，２５　ジャイロスコープ
２　上側ガラス基板（基材）
３　下側ガラス基板（基材）
４　駆動用電極
５　検出用電極
６　音叉
７　駆動用フィードスルー（駆動用線路部）
８　検出用フィードスルー（検出用線路部）
９　脚（振動片）
１０　支持部
１１　枠部
１２　駆動用配線（駆動用線路部）
１３　検出用配線（検出用線路部）
１９　検出－駆動間遮蔽部（第１の遮蔽部材）
２０　検出－検出間遮蔽部（第２の遮蔽部材）
２１　駆動－駆動間遮蔽部（第２の遮蔽部材）
２６　検出－駆動間遮蔽配線（第１の遮蔽部材）
３０　ペン型マウス（入力装置）

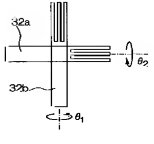
【図１】



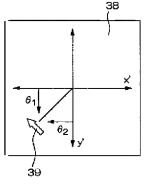
【図２】



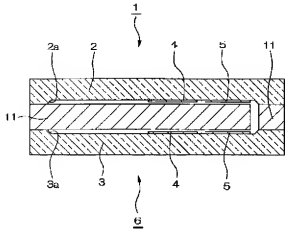
【図８】



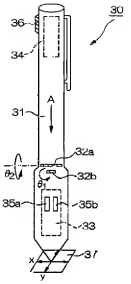
【図９】



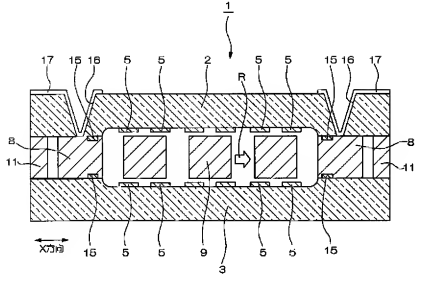
【図3】


1
2a
2
4
5
11
11
3a
3
4
5
6

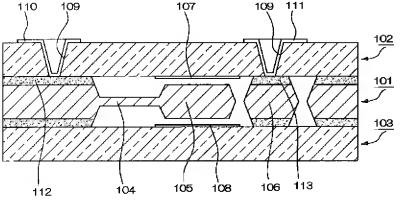
【図7】


30
36
34
A
31
32a
32b
θ2
θ1
35a
35b
33
37
x
y

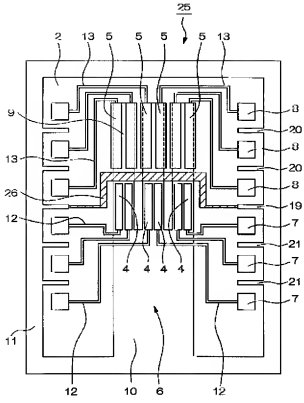
【図4】


1
17
15
16
5
5
2
5
R
5
15
16
17
8
11
8
11
15
5
5
9
3
5
5
15
X方向

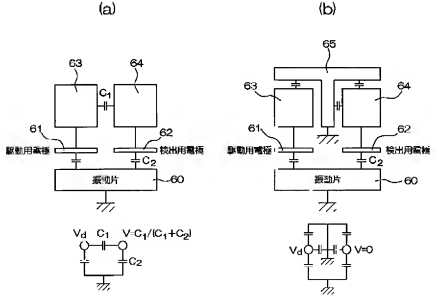
【図10】


110
109
107
109
111
102
101
103
112
104
105
108
106
113

【図5】


25
2
13
5
5
5
5
13
9
8
20
13
8
20
28
8
19
12
7
21
4
4
4
4
7
21
7
11
12
10
6
12

【図6】


(a)
(b)
63
64
65
C1
61
62
駆動用電極
検出用電極
C2
振動片
60
Vd
C1
V·C1/(C1+C2)
C2
V=0

フロントページの続き

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